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THE NUTRITION OF PLANTS.

Artificial Manures, their Chemical Selection and Scientific Application to Agriculture. By M. Georges Ville. Translated and edited by Sir William Crookes, F.R.S. New edition, revised by Sir William Crookes, F.R.S., and Prof. John Percival. Pp. xxxviii + 347. (London: Longmans, Green and Co., 1909.) Price 10s. 6d. net.

SIR WILLIAM CROOKES and Prof. Percival have revised and re-issued the lectures given by Georges Ville at the experimental farm at Vincennes during 1867 and 1874-5, and originally translated by Sir William in 1879.

"It is only just, he says in introducing the volume, "that its claims to be regarded as a classic and its author's right to the title of pioneer should not be forgotten when many of Prof. Ville's views are so generally adopted that his prescience and acumen are likely to be underrated and his priority unrecognised."

Ville was an ardent supporter of Liebig's views on the nutrition of plants. He was one of the brilliant band of men who at that time were developing and spreading the new ideas; several of the lectures deal with his experiments showing that a full crop can be obtained by supplying the proper food-stuffs in inorganic combination. It is difficult for us now to realise the astonishment with which the older farmers saw crops raised solely by the aid of "chemical" manures without the dung which had always been supposed essential. Lawes and Gilbert showed that it was not; they also falsified the prediction of many of their critics that chemical manures would soon exhaust their land and leave it sterile. Ville went even further, and maintained that artificial manures were unquestionably more remunerative, and afforded, indeed, the only means of keeping up the fertility of the soil. A man who only used dung, he said, must exhaust his land. This is the characteristic note of a great part of the book.

The chemical manures were compounded on a definite plan. For each crop one of the three constituents nitrogen, potash, and phosphoric acid was found to be more necessary than the rest, and was therefore called the dominant constituent. Thus nitrogen was the dominant constituent for cereals and beetroot; potash for potatoes and vines; calcic phosphate for the sugar-cane; there was no dominant, however, for flax. An excess of the dominant constituent was always added to the crop manure.

Great stress was laid on the fundamental differences in nitrogen nutrition between leguminous plants and cereals; nitrogenous manures are not necessary for the leguminosæ, whilst they are for other plants. M. Ville had played a very prominent part in the great controversy that continued during many years as to the source of nitrogen in plants. It seems to have been begun by Priestley, who stated that a plant of *Epilobium hirsutum*, placed in a small vessel, absorbed

during the course of a month seven-eighths of the air present. He therefore concluded that plants assimilated nitrogen, but this view was soon controverted by Ingenhousz, de Saussure, and others, and was for a time disposed of by the classical experiments of Boussingault. Ville, however, revived it, and his experiments, begun in 1849 and described in two very beautiful volumes, "*Recherches expérimentales sur la Végétation*" (1853 and 1857), appeared to show that all the plants examined, rape, wheat, barley and maize, actually did take some of their nitrogen from the air. Somewhat later, Lawes, Gilbert and Pugh repeated the experiments but failed to confirm the result. They even used his experimental vessels, which are still to be found among the treasures of the Rothamsted laboratory.

It is not our intention to discuss this discrepancy in the light of subsequent discoveries; we need only point out that Ville was perfectly correct so far as the leguminosæ are concerned, and that his error with regard to other plants did not lead him astray in making up his manures.

No value was placed upon soil analysis; "at the present time the most laborious analysis is not able to throw light upon the most vital and essential question of practical agriculture." The deficiencies of the soil are determined by trials with the plants themselves. Plots are directed to be laid out in the field as follows:—

(1) With the normal (*i.e.* complete) manure; (2) normal manure without nitrogen compounds; (3) normal manure without phosphates; (4) normal manure without potassium compounds; (5) normal manure without calcium compounds; (6) unmanured.

This is substantially the scheme now adopted in almost every county in England. Under his supervision large numbers of such experiments were carried out in France. Some of the results are astonishing. In one case a plot receiving 32 tons of farmyard manure per acre gave a crop of 14 bushels per acre whilst a neighbouring plot receiving half a ton of chemical manure per acre yielded 36 bushels. There was a loss of about 19*l.* in the former case and a gain of about 17*l.* in the latter.

Ville's main thesis that crops can be grown with chemical manures had already been demonstrated by Lawes and Gilbert, with whose names it will for ever be associated in England, and is now a commonplace in practical agriculture. His view that chemical manures are in all circumstances better than dung has not survived. He made no allowance for the wonderful effect of the organic matter present in the dung in improving the texture and water-holding capacity of the soil—an effect not shown at all, or even shown in an adverse sense, by artificial manures. When we remember how large a part of the farmer's labour is devoted to cultivation it is easy to understand his preference for dung. Indeed, on many soils addition of organic matter is absolutely indispensable. Further, it may be doubted whether we possess even yet the data necessary for working out the relative costs of farmyard and artificial manures in the complex conditions of modern farming, with its inter-

dependence of crops and of live stock and its fluctuating financial equilibrium. Nor have Villé's formulæ for compound manures survived. The amount of food a plant requires is known to be modified by the water supply, the temperature, and the general soil conditions. It is clear that no one formula could possibly suit all cases; indeed, we might sum up the difference between Ville's views and those current now by saying that Ville regarded the supply of plant food as the dominating factor in determining fertility, whereas we now know it is only one of several equally important factors.

The lectures are interesting to read and must have been delightful to hear; they will form valuable material for the historian of agricultural science when he arises, not only by reason of the views set forth, but also because of the numerous balance-sheets and statements of costs. For their historical interest also they will be read by the serious student of agricultural chemistry, who indeed is already attracted to them by the fact that they have interested Sir William Crookes.

Certain alterations have been made in the text, so that the lectures are not quite in their original form. The editors have preferred to do this rather than to make corrections in footnotes, a plan which, if more cumbersome, would have had the advantage of preserving the historical value of the book. A chapter has also been added on the fixation of atmospheric nitrogen. All fixation methods attract much popular attention, while the electrical method first indicated by Sir William Crookes is already a rich and promising addition to our agricultural resources.

E. J. RUSSELL.

MODERN CHEMISTRY.

Handbuch der anorganischen Chemie. Herausgegeben von Dr. R. Abegg und Dr. F. Auerbach. Dritter Band, Zweite Abteilung. Pp. xii+921. (Leipzig: S. Hirzel, 1909.)

THIS stately volume of more than 900 pages treats of the elements of the fourth group of the periodic system, namely, C, Si, Ti, Ge, Zr, Sn, Pb, and Th. It opens with an excellent comparative summary by Abegg and Brauner of the general chemical and electrochemical relationships of the members of the group. Then comes a truly magnificent monograph on carbon by Weigert, covering 276 pages, with a literature-index containing 1307 references. It would be quite impossible in a short notice such as the present to give any adequate idea of the masterly manner in which the author has dealt with his great subject, so that a few references must suffice. In dealing with the allotropic forms of carbon, the usual purely descriptive account is followed by an extraordinarily interesting discussion of the energy- and stability-relationships, in which the researches of Schenck and Heller, and of Smits, are dealt with. The author also applies Nernst's theorem to the problem of the transition-point between diamond and graphite, but an arithmetical error appears to have crept into his calculation here.

The highly important theoretical and experimental researches on the formation, dissociation, and stability-

relationships of the hydrocarbons are treated very fully, Nernst's thermodynamical theorem serving here (as elsewhere) as a basis for calculation. A good account is also given of Bone's work on the oxidation of hydrocarbons.

Under the heading of "Flame" the author does not fail to give us a lucid account of the modern work of Haber and his collaborators, whilst the subject of explosions introduces the reader to the work of Mallard and Le Chatelier and Dixon.

The chemistry of carbon has afforded the author a splendid opportunity of familiarising the chemist with the thermodynamics of high-temperature gas equilibria, and he has taken good advantage of it. The treatment of such highly important subjects as the dissociation of CO_2 , the $\text{C}-\text{CO}_2-\text{CO}$ equilibrium, the water-gas equilibrium, and various heterogeneous gas-equilibria, such as $\text{C}-\text{N}-\text{C}_2\text{N}_2$, $\text{C}-\text{S}-\text{CS}_2$, $\text{C}-\text{NH}_3-\text{HCN}-\text{H}$, is excellent. The treatment of these matters brings the author to the discussion of such fundamental questions as the free energy of carbon combustion and the quantitative measure of the reducing power of carbon and its simpler gaseous compounds. What a vista is opened here to those who have the eyes to see and the minds to understand! It is a painful reflection to realise how soon all this will be as familiar to the trained modern German chemist as the laws of Dalton and Avogadro, whilst the progress of scientific chemistry in this country is still retarded by the false prophets who are affrighted by the sight of an algebraical symbol, and grievously lament the advance of physical chemistry.

There is an excellent and suggestive account of photochemical plant synthesis, and of the free-energy changes involved in biological metabolisms.

The heterogeneous equilibria presented by solid CO_2 in its various forms, and the ionic dissociation of aqueous solutions of carbonic acid, are well treated. More technical questions, such as the manufacture of coal gas, the calorific power of fuels, and the light efficiency of burning oils, come in for their share of discussion.

Enough has been said to give some idea of the scope and method of this splendid monograph. It is to be sincerely hoped that English chemists will carefully study it.

The next article (by Grossmann) deals with silicon and its compounds, and is full of interesting things. As befits the theme, a very full account is given of SiO_2 , the silicic acids, and the silicates. Here we find an excellent *résumé* of Tschermak's interesting researches on the constitution of the silicates, together with the criticisms of Jordis, van Bemmelen, and Mügge thereon.

Another very interesting section deals with the work of Vogt, Doelter, and Allen and Day on the silicate melts.

Silicon is followed by a compact and up-to-date article of twenty pages on glass, by Schaller.

Titanium is dealt with by Jacoby. Here we find a very full discussion of the important work of Diethelm and Foerster on the electrochemical reduction of acid titanate sulphate solutions.

Germanium and zirconium are well presented by